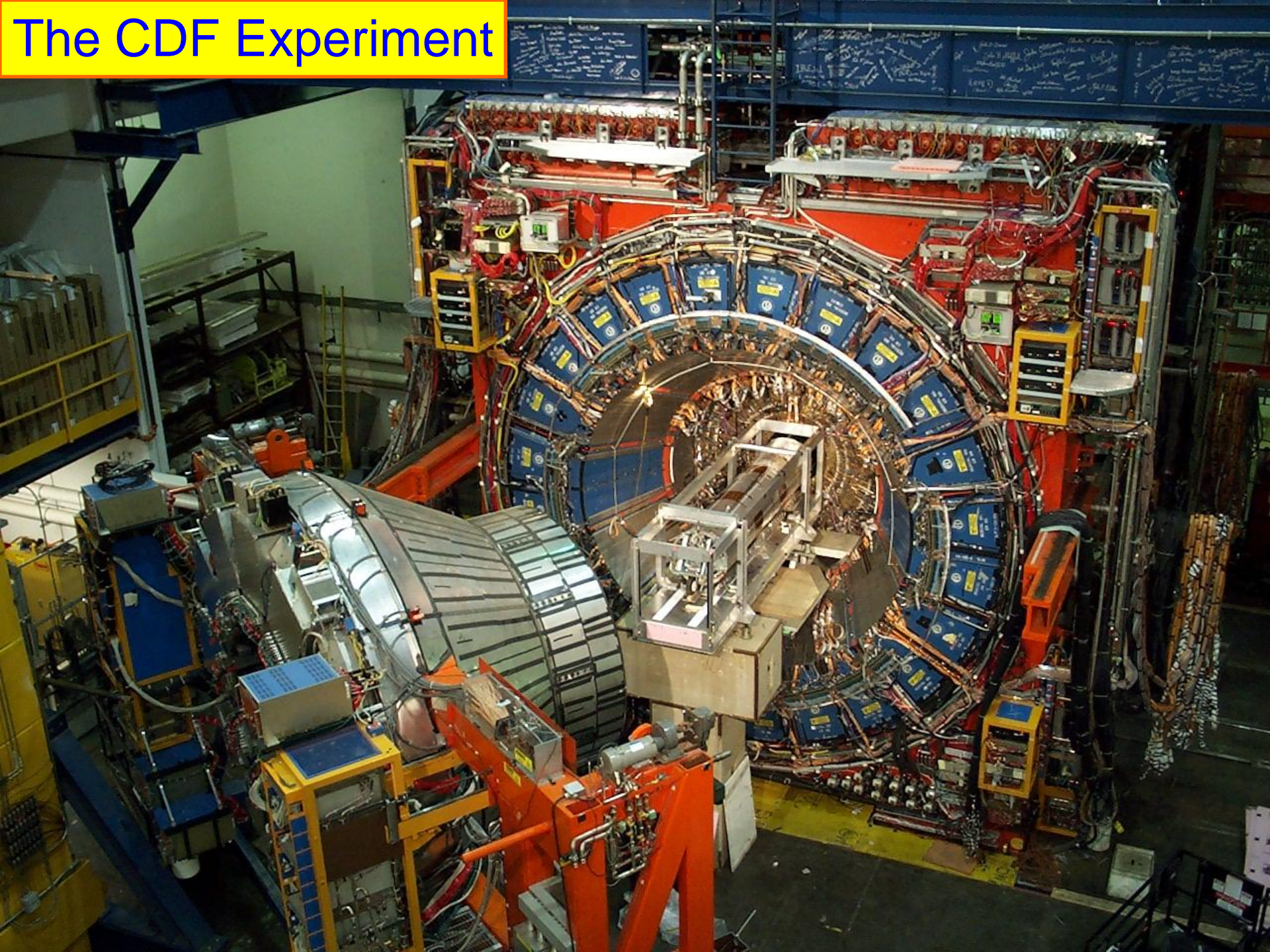


# CDF Collaboration and Detector Status

Rob Roser and Giovanni Punzi

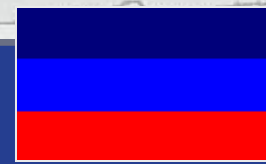


# The CDF Experiment





# The CDF Collaboration as of Today



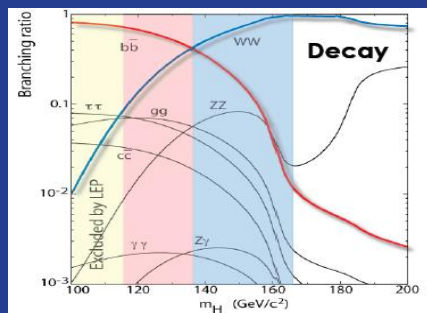
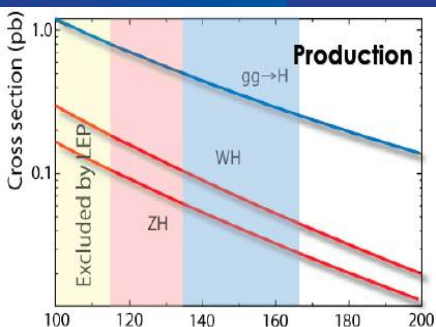
# Some Recent Physics Highlights from CDF

World Class Physics

- ✓ Observation of Bs-mixing
  - $\Delta m_s = 17.77 \pm 0.10 \text{ (stat)} \pm 0.07 \text{ (sys)}$
- ✓ Observation of THREE new baryon states
  - $\Sigma_b$  and  $\Xi_b$  and  $\Omega_b$
- ✓ WZ discovery (6-sigma)
  - Measured cross section 5.0 (1.7) pb
- ✓ ZZ observation
- ✓ Observation of new charmless  $B \Rightarrow hh$  states
- ✓ Observation of exclusive/diffractive production
  - Di-jets, W/Z, charmonium, etc
- ✓ Observation of  $D^0$ - $D^0$ bar mixing
- ✓ Observation of Single Top Production
- ✓ First Observation of Vector Boson Pairs in a Hadronic Final State
- ✓ Measurement of  $\sin(2\beta_s)$
- ✓ Precision W mass measurement
  - ✓  $M_{W\_cdf} = 80.413 \text{ GeV (48 MeV)}$
- ✓ Precision Top mass measurement
  - ✓  $M_{top\_cdf} = 172.4 \text{ (1.3) GeV}$
- ✓ W-width measurement
  - ✓ 2.032 (.071) GeV
- ✓ Extended exclusions on BSM
- ✓ Continued improvement in Higgs Sensitivity

# CDF High Mass Higgs

## Fridays W+C Result (6/17)



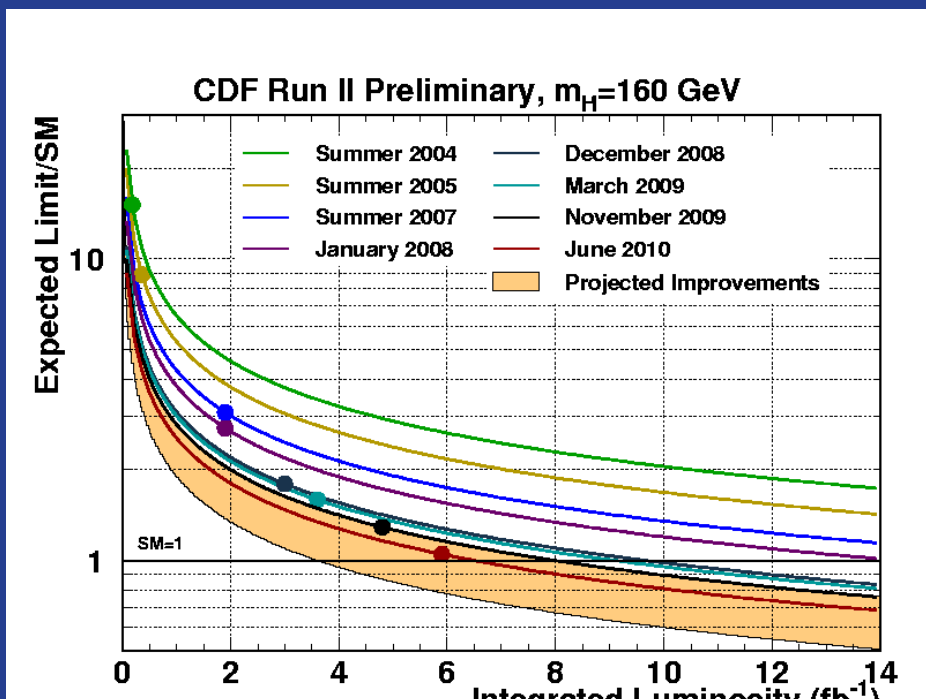
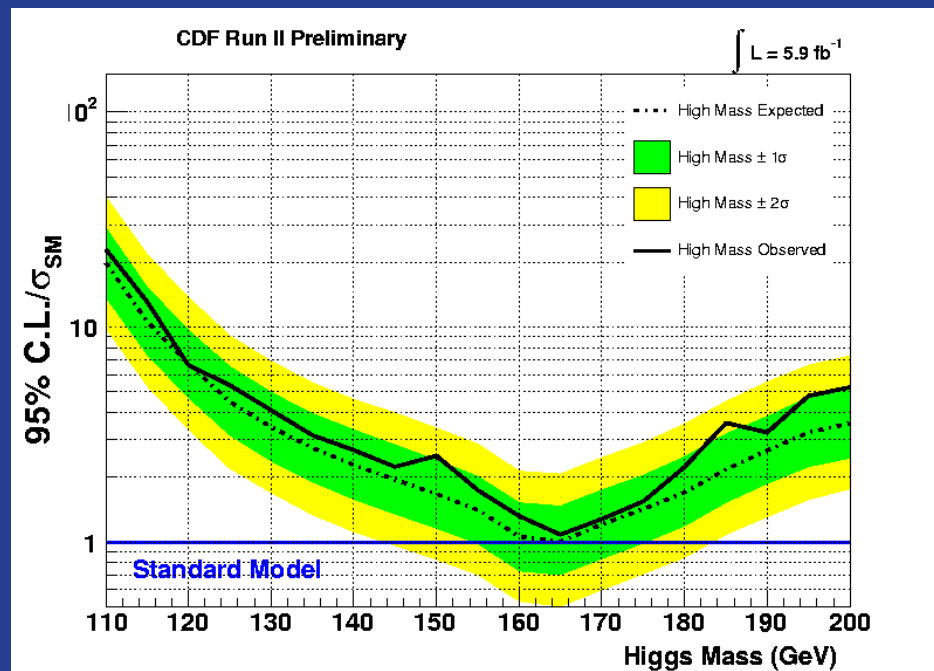
## Improvements Still to Come

### ■ Add more acceptance

- Addition of lower  $p_T$  leptons and triggers
- Investigate loosening isolation cut on leptons

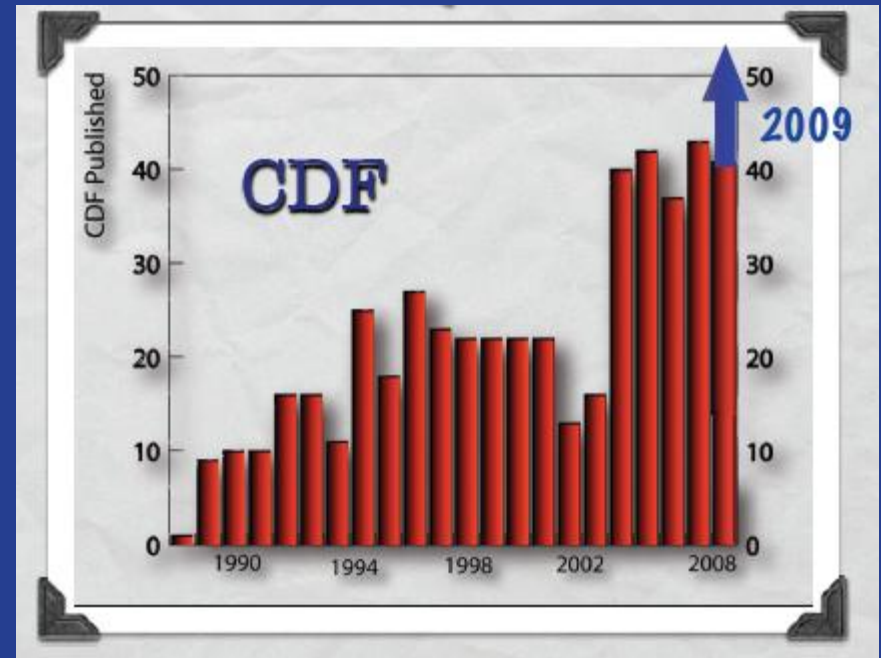
### ■ Improve analysis techniques -- Still many ideas!

- Optimize neural networks for low/high mass separately, improve missing  $E_T$  description, study lepton isolation...



# Measuring Success through Publications and PhD's

- 60 papers published in 2009
- 18 published thus far in 2010 and 19 submitted for publication
- ~40 analyses under collaboration review



On track for 50+ publications in 2010

## PhD's Awarded

- 85 awarded since January 2008
- 250 awarded for work on Run II data
- 514 CDF students received PhD's thus far

# Detailed List of 2010 “Winter Conf” Results

## QCD Physics

Analysis	Luminosity	More Information
Measurement of the inclusive $Z/\gamma^* (\rightarrow \mu^+\mu^-) + \text{jets}$ cross section	2.4 fb <sup>-1</sup>	<a href="#">WebPage</a>
Quantifying jet energy resolution using Z+jets	4.6 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the W+single charm cross section	4.3 fb <sup>-1</sup>	<a href="#">WebPage</a>
Hyperon production in minimum bias events	3.0 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the W+b jet cross section	1.9 fb <sup>-1</sup>	<a href="#">WebPage</a>

## Electroweak Physics

Analysis	Luminosity	More Information
Search for the decay $W \rightarrow \mu \tau$	4.3 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the Z forward-backward asymmetry	4.1 fb <sup>-1</sup>	<a href="#">WebPage</a>
Limits on neutral anomalous couplings from Z+ $\gamma$ events	2.0 fb <sup>-1</sup>	<a href="#">WebPage</a>
Observation $ZZ$ production in the four charged lepton final state	4.8 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the WW/WZ cross section in $lv jj$	4.3 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the WW/WZ cross section in $lv jj$ using a matrix element technique	4.6 fb <sup>-1</sup>	<a href="#">WebPage</a>

## Top Physics

Analysis	Luminosity	More Information
Measurement of the top quark mass using a matrix element technique	4.8 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the top quark mass using lepton+jets and dilepton events	4.8 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the top quark width using lepton + jet events	4.3 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the t-tbar production cross section in the missing transverse energy + jets channel	2.2 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the t-tbar production cross section using a neural net b-tagging algorithm	4.3 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the helicity fractions and spin correlation in top quark pairs	4.3 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the W-boson helicity fractions in top quark decays	2.7 fb <sup>-1</sup>	<a href="#">WebPage</a>
Search for a heavy 4th generation up-type quark in lepton + jet events	4.6 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of the top quark charge using soft lepton tagging	2.7 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of s- and t-channel single top quark production	3.2 fb <sup>-1</sup>	<a href="#">WebPage</a>



# Winter Conf Cont...

## Exotic Physics

Analysis	Luminosity	More Information
Search NMSSM Higgs boson in top quark decays	2.5 fb <sup>-1</sup>	<a href="#">WebPage</a>
Search for production of MSSM Higgs boson in association with b quarks	2.5 fb <sup>-1</sup>	<a href="#">WebPage</a>
Search diboson (WW/WZ) resonances in electron + 2 jets + missing transverse energy	2.5 fb <sup>-1</sup>	<a href="#">WebPage</a>

## Bottom Physics

Analysis	Luminosity	More Information
Measurement of b-hadron lifetimes in decays to $\mu^+\mu^-$	4.3 fb <sup>-1</sup>	<a href="#">WebPage</a>
Observation of $B_s \rightarrow \phi\mu\mu$ and measurement of $B_s \rightarrow K^{(*)}\mu\mu$	4.4 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of resonant $B \rightarrow \mu^+\mu^-\pi^+\pi^-$ decays	2.4 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of $B \rightarrow \mu^+\mu^-\pi^+\pi^-$ decays	2.9 fb <sup>-1</sup>	<a href="#">WebPage</a>
Measurement of $B_s \rightarrow \phi\phi$ decays	2.9 fb <sup>-1</sup>	<a href="#">WebPage</a>

## Higgs Physics

Analysis	Luminosity	More Information
Tevatron Higgs combination	5.4 fb <sup>-1</sup>	<a href="#">WebPage</a>
CDF Higgs Combination	4.8 fb <sup>-1</sup>	<a href="#">WebPage</a>
Search for $WH \rightarrow l \nu b\bar{b}$ Events	4.8 fb <sup>-1</sup>	<a href="#">WebPage</a>
Search for $H \rightarrow WW^*$ and $WH \rightarrow WWW^*$	5.3 fb <sup>-1</sup>	<a href="#">WebPage</a>
Search for $WH/ZH \rightarrow qqbb$ Events	4.0 fb <sup>-1</sup>	<a href="#">WebPage</a>
Search for $H \rightarrow \gamma\gamma$	5.4 fb <sup>-1</sup>	<a href="#">WebPage</a>

Expect 50-60 new 6/fb results for ICHEP



# Bottom Line...

- Even Though
  - Our collaborations are shrinking
  - The LHC has started up and continues to
- We are still getting it done
  - Keeping up with the data
  - Publishing more papers now than in our history
  - Awarding a large number of PhD's
  - Improving our analyses and not just adding luminosity
  - We have what it takes to accomplish our physics goals

# Effort Required to Operate CDF Today

	<u>Today</u>
Operations	40 FTE
Offline	15 FTE
Management	10 FTE
Algorithms	10 FTE
Total Effort	75 FTE

- 40% less than just a few years ago
- This is the effort required to do everything except the physics analysis itself

# Survey of PI's re Level of Involvement

	2009	2010	2011*
tot FTE	292	259	191
U.S.	46%	48%	50%
postdocs	71	71	47
students	100	81	51
fac. level	121	107	93

**\*2011 numbers from 2009 Survey** – at which point it was not clear we would be running -- expect actual numbers ~2010



# Survey of Collaboration re 3 more years

- We asked Three Questions
  - Do you think the Tevatron should run longer?
  - Would you or a member of your group like to participate
  - Would you/your group sign an EOI

	Run Longer	Involved?	Sign EOI
<b>59 responses</b>	<b>54 in favor</b>	<b>50 yes</b>	<b>50 yes</b>

Institutions who will sign the EOI listed on the next page

# Institutions interested in Running Tevatron through 2014

Rochester  
Dubna  
Athens  
Glasgow  
Padova  
Johns Hopkins  
Wisconsin  
Florida  
Madrid  
Korea  
UCL  
Tsukuba  
Michigan  
Slovakia  
Carnegie Mellon  
Contabria  
Osaka  
Oxford  
Toronto  
Helsinki

Chicago  
Ohio State  
Bologna  
Paris  
Barcelona  
Tufts  
Rutgers  
Wayne St.  
Harvard  
Karlsruhe  
Liverpool  
Rockefeller  
Fermilab  
Duke  
Baylor  
Davis  
Frascati  
UCLA  
Illinois  
MIT

Waseda  
PITT  
Taiwan  
Trieste/Udine  
PISA  
Virginia  
Purdue  
Brandeis  
Okayama  
Michigan State

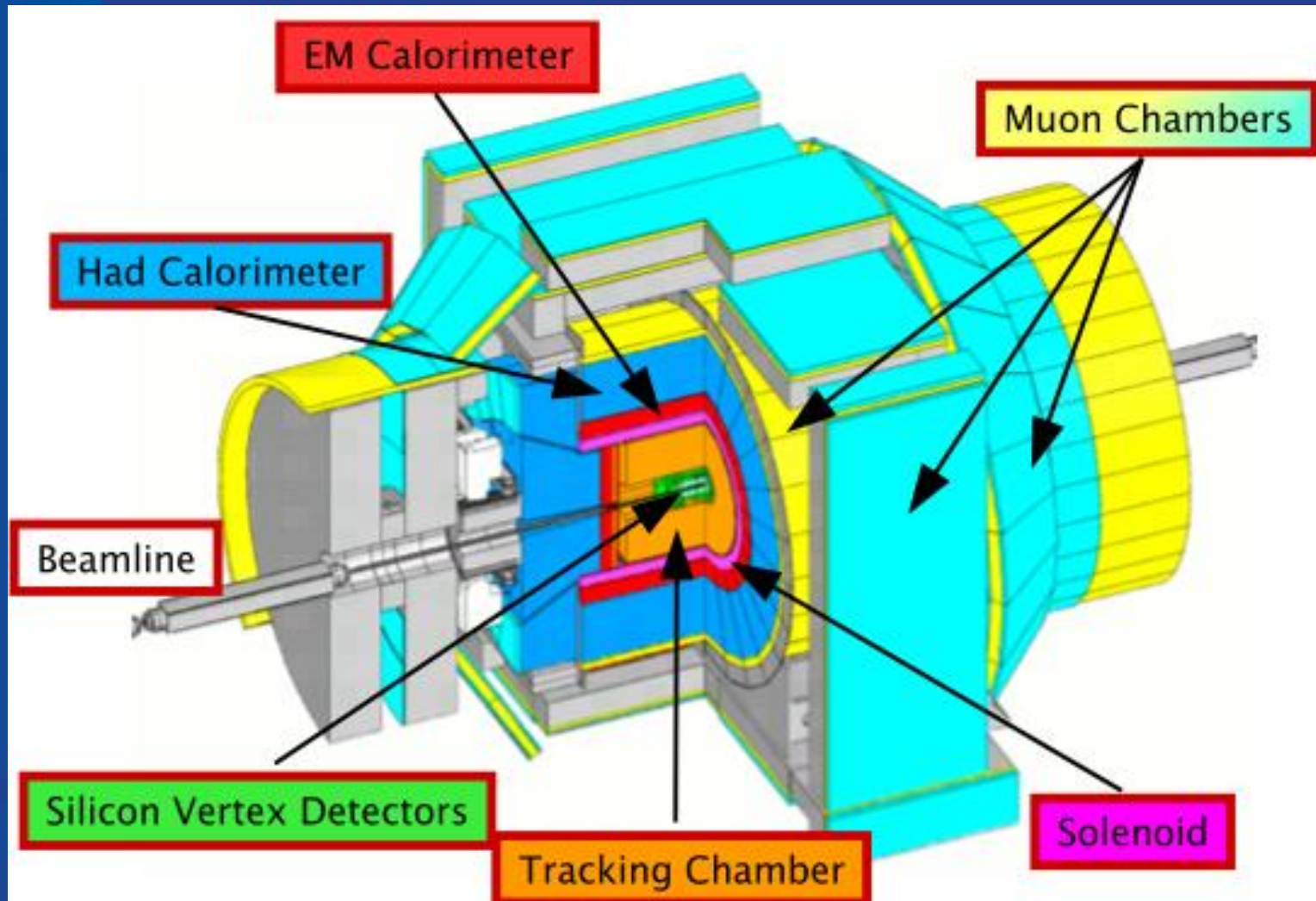
**50  
Institutions!**

# Detector Longevity



# The CDF II Detector

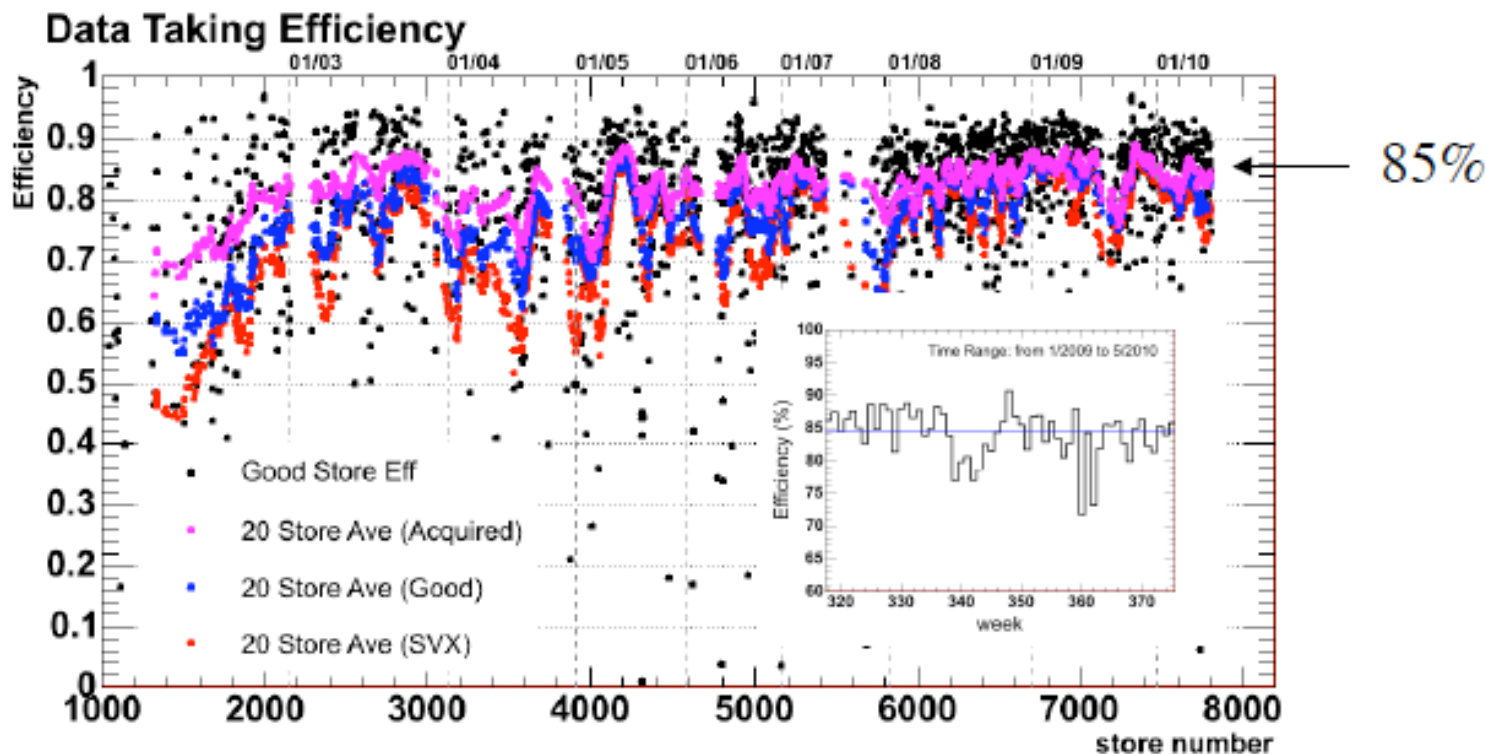
General multipurpose detector with excellent tracking and mass resolution:



# Overall Status

- Commissioned a detector vulnerability study in 2007 using outside “consultants”. (Reports available upon request)
  - Followed up on their recommendations
  - Thus we are in quite good shape overall WRT continued running
- Luminosity and loss monitors, Calorimeter, TOF, Muon systems running well
- Cryo, gas and cooling systems all stable with no issues
- Aging on-line Computing that will need attention in a run extension

# Smooth Detector Operations



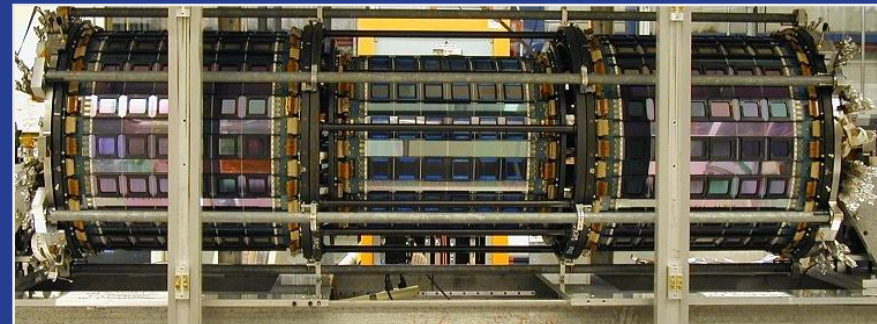
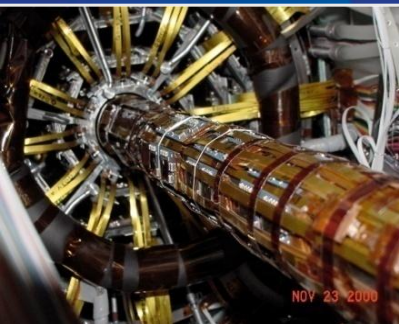
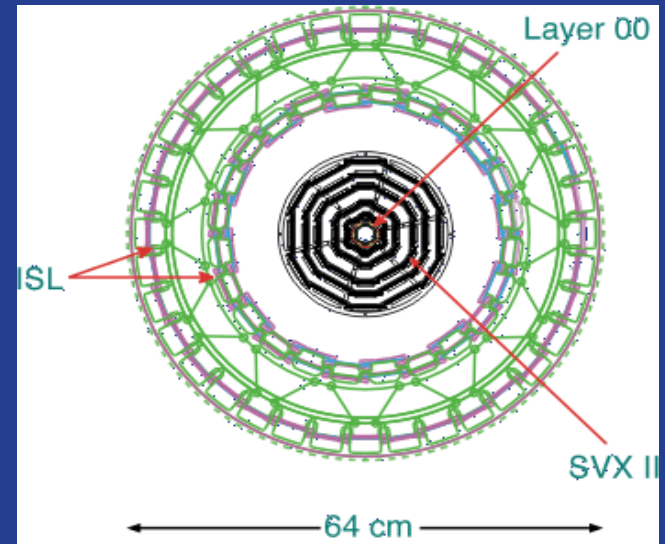
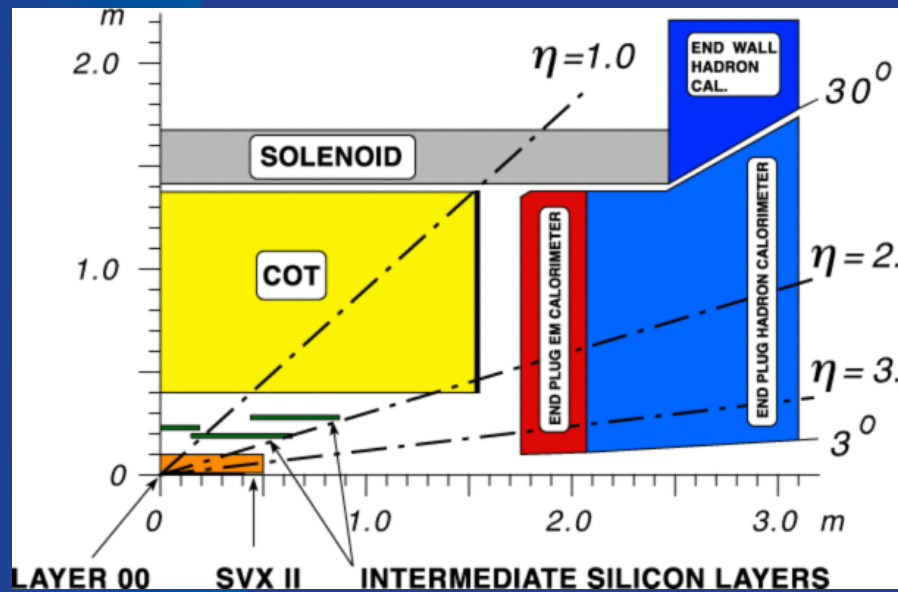
Time – beginning of run till now



# Tevatron Tracker Review

- Held on 6/7 – organized jointly with PPD Hed Mike Lindgren and Tevatron Spokes.
- Dan Green chaired committee – other members include Steve Worm(Rutherford Lab), Rainer Walny (UCLA) , Marcel Demarteau (FNAL), Alan Bross (FNAL)
- Each Collaboration Gave 3 talks
  - Overview of the Experiment
  - Status of Silicon Detector
  - Status of outer tracker
- Review was on the hardware performance only
- Physics impact studies still on-going

# Silicon Detector



# Silicon Detector – Issues to Watch

## Radiation damage to sensors:

- Will the depletion voltage eventually exceed the sensor breakdown voltage and/or power supply limits?
- How will the decreasing S/N ratio affect the physics analyses?
- SVX3D chips were tested only to 1MRad dose

## Aging infrastructure and electronics:

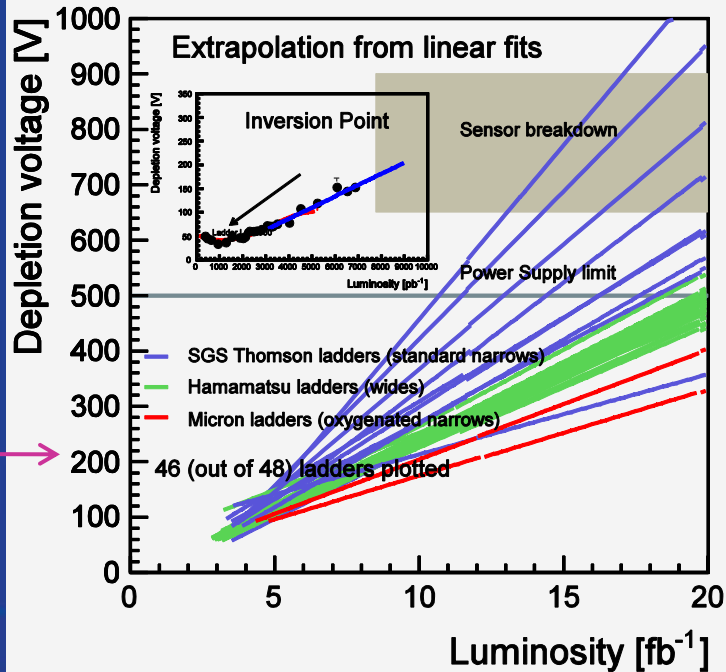
- Spare pools – where are they shallow?
- Radiation damage to internal DOIM data transmitters
- Cooling system – status after 2007 leaks and repairs

## Manpower and loss of expertise:

- Can we sustain the 5-10 FTEs required to keep the detector in optimal shape?
- Can we keep old experts in the loop so we don't lose knowledge and repeat mistakes?

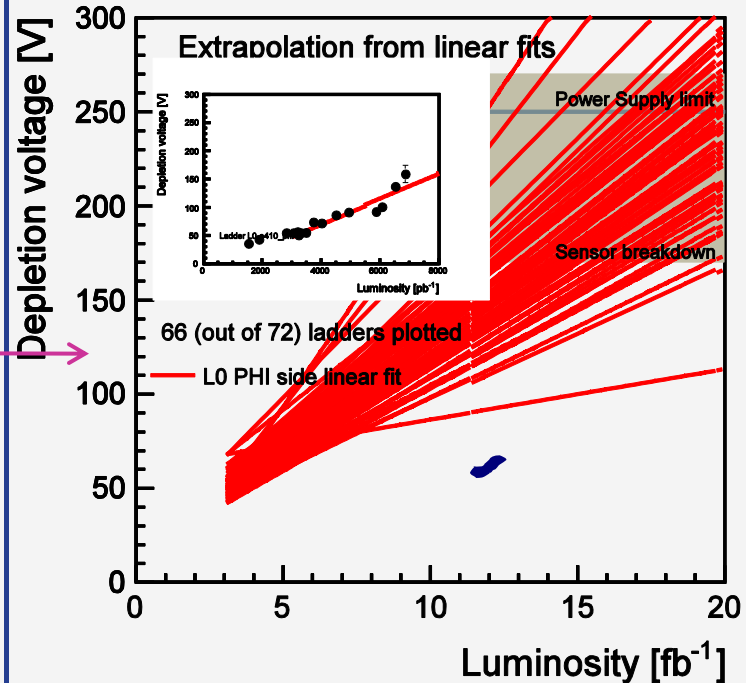
# Depletion Voltage Projections

## Prediction for L00



where we are now

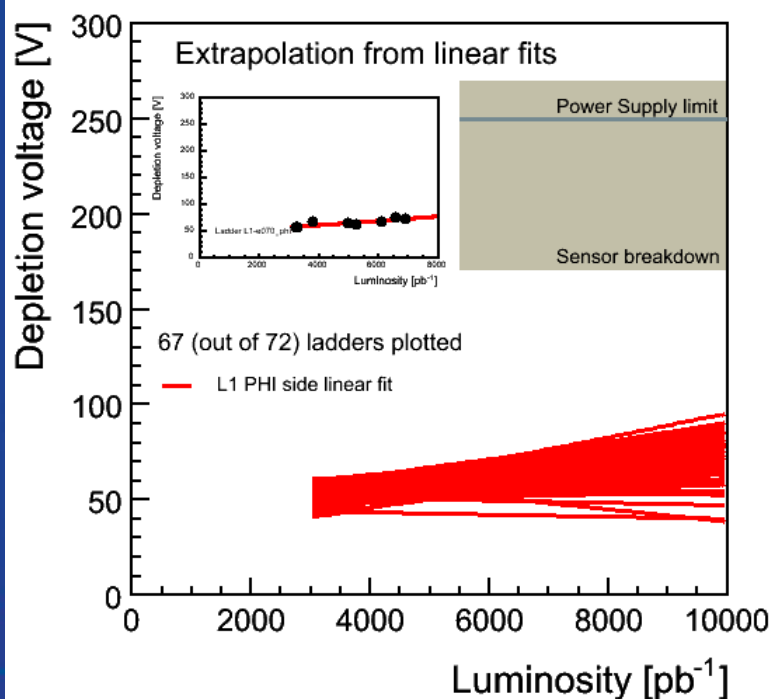
## Prediction for SVX-L0



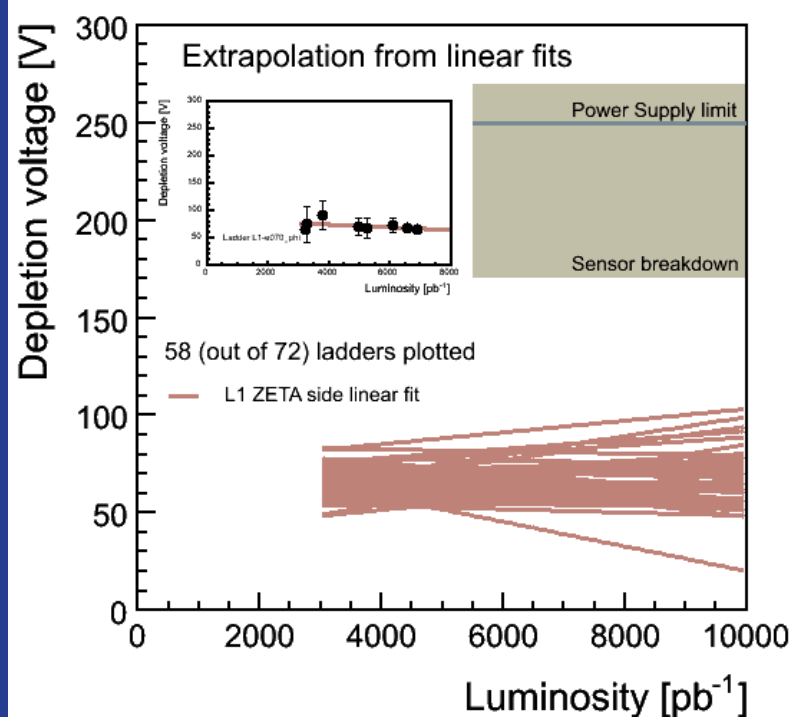


# Depletion Voltage Projections

## Prediction for L1 – phi side

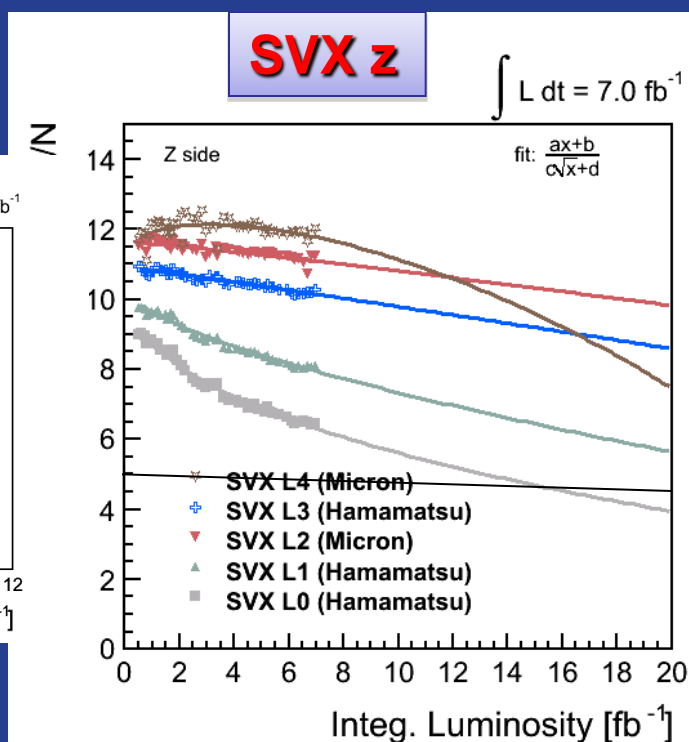
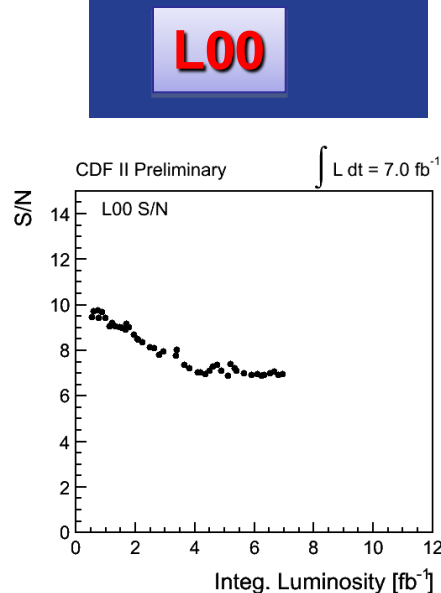
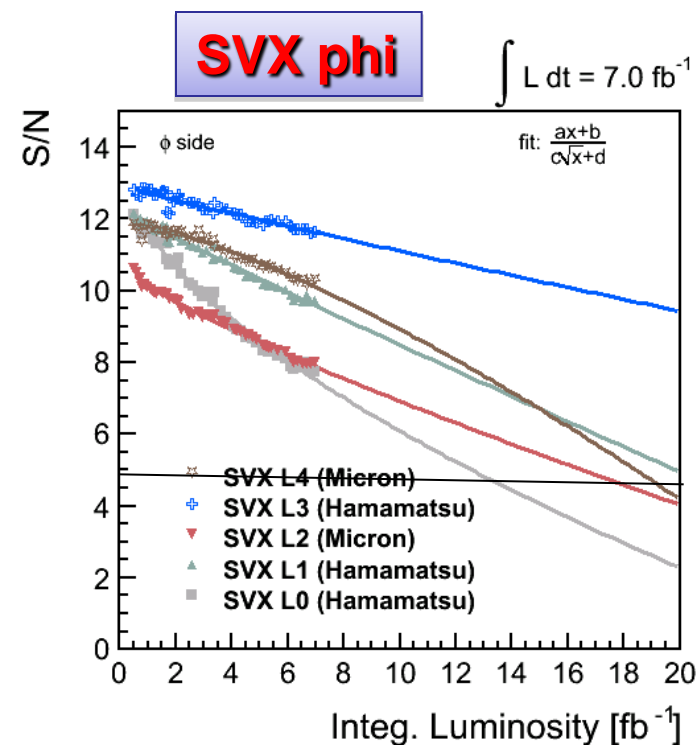


## Prediction for L1 – z side



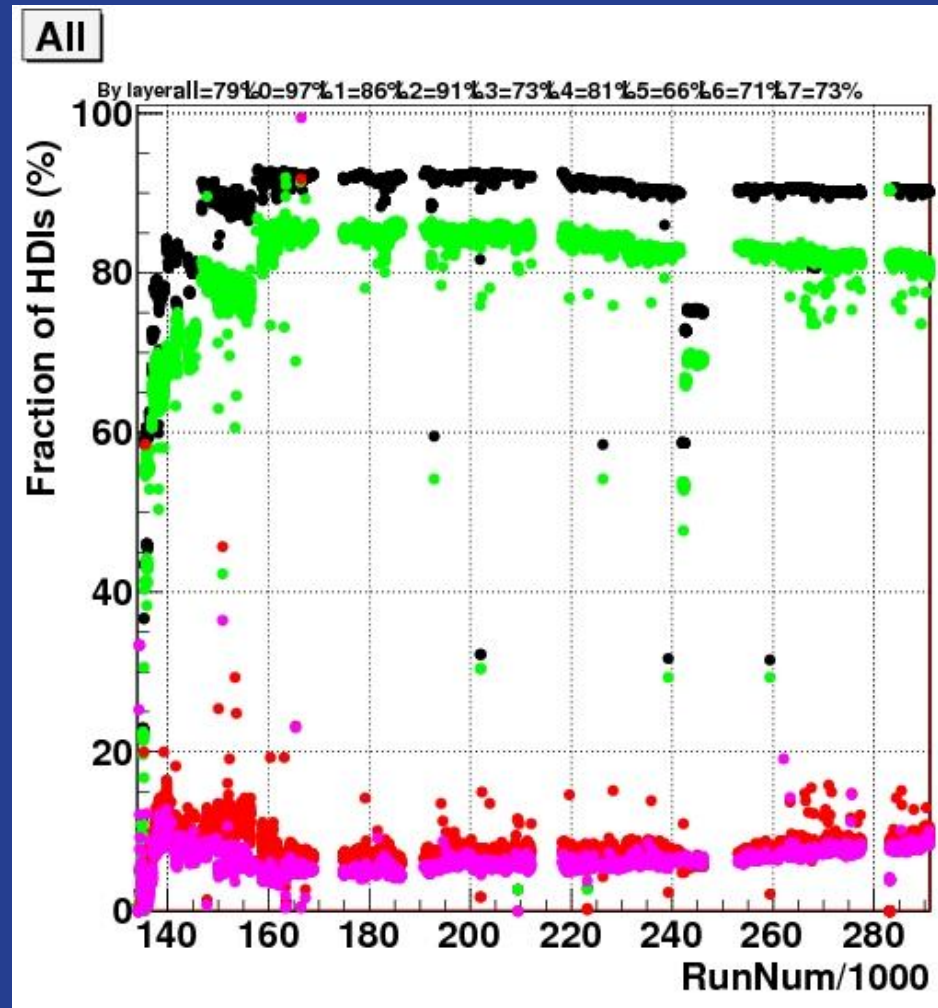
# SVXII Signal / Noise Projection

- Signal from  $J/\psi \rightarrow \mu^+\mu^-$  tracks strip cluster charge
- Noise estimation from regular calibrations
- Extrapolations assume fully depleted sensors
- Studies in progress to understand the effect of decrease S/N on physics analyses



# Ladder Failures and Challenges

- Radiation damage in the sensors is not the only issue
- We use almost every access for diagnostic and repair work
- Currently ~90% ladders integrated, ~80% good (< 1% error rate), ~10% bad with an average error rate of 10%
- Our Motto : No Ladder Left Behind



Great Performance after 9 years of Running

# Chip Accounting - SVX

## Common failure modes:

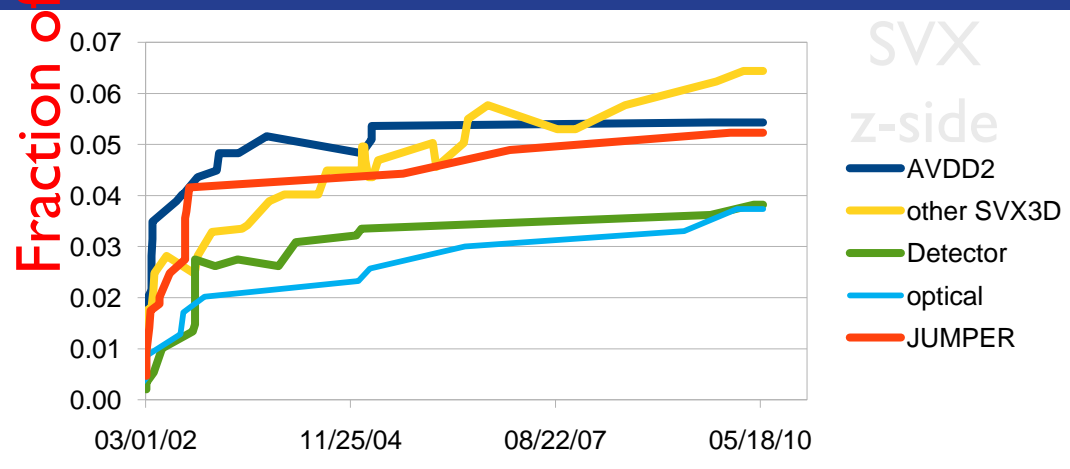
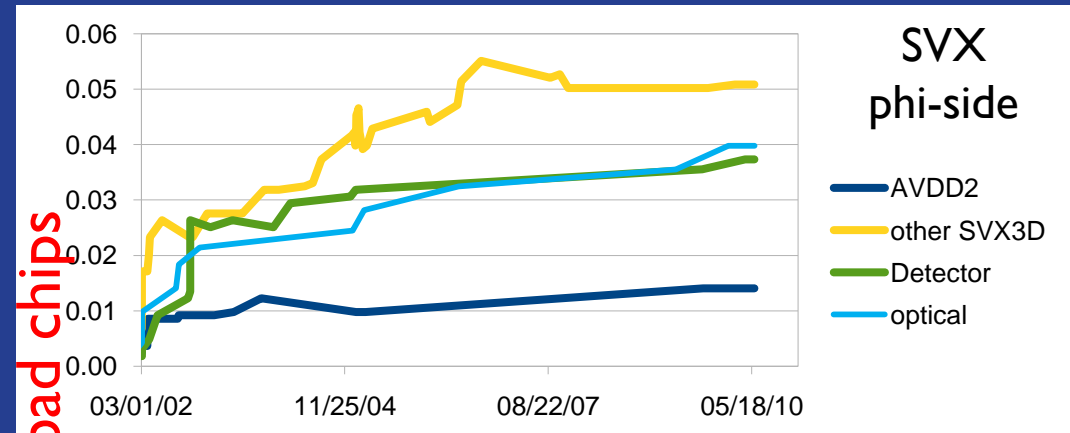
**Detector** includes port cards, junction cards, cables, and the sensors themselves.

**Optical** is bit errors from the internal DOIM data transmitters

**Jumper** is SVX3D chip failures due to wire bond resonances

**AVDD2** is a SVX3D chip failure mode caused by thermal cycles

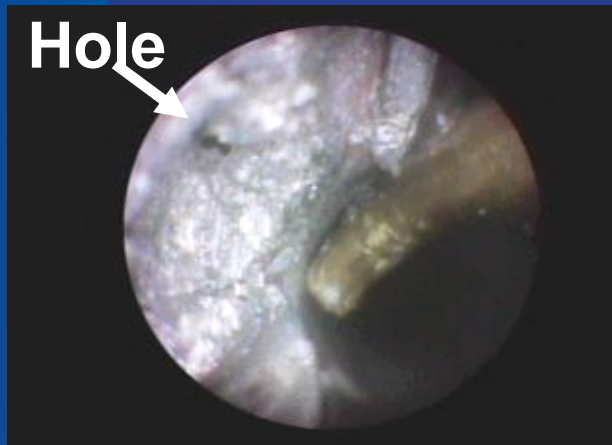
**Other SVX3D** includes all other chip failure modes



**STABLE!!!**

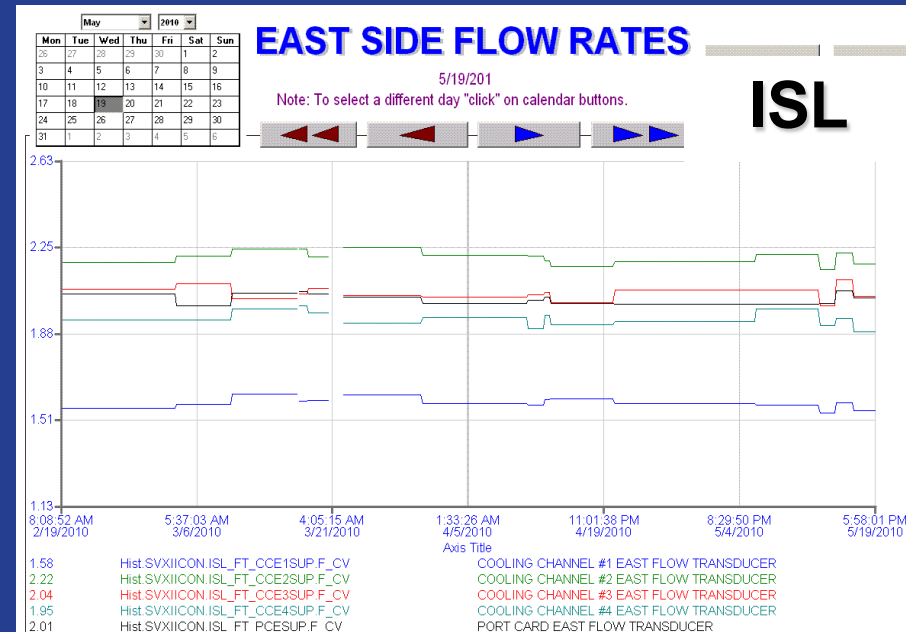
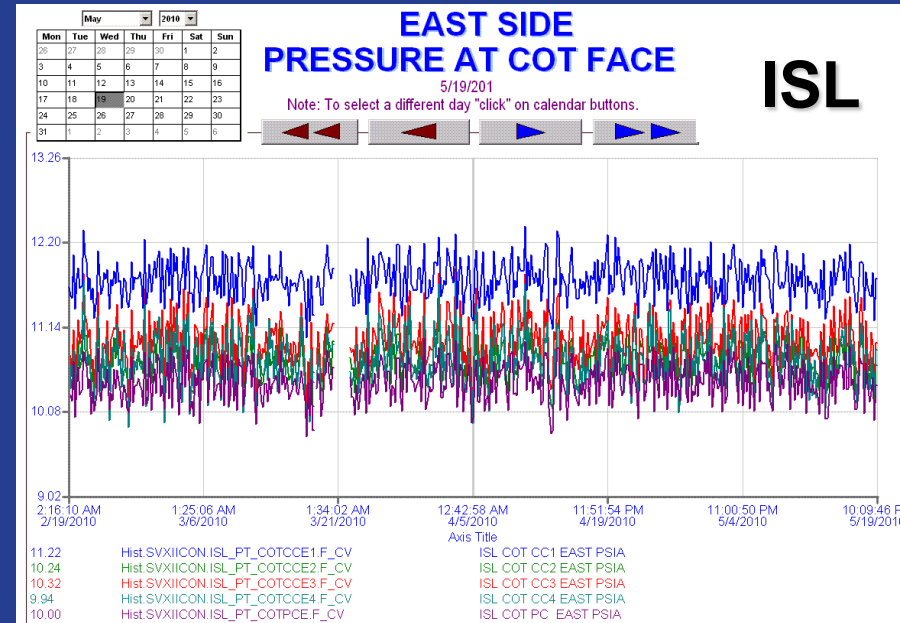
# ISL Cooling

Reminder – leaks developed in 2007 – repaired with epoxy from the inside



## Current status

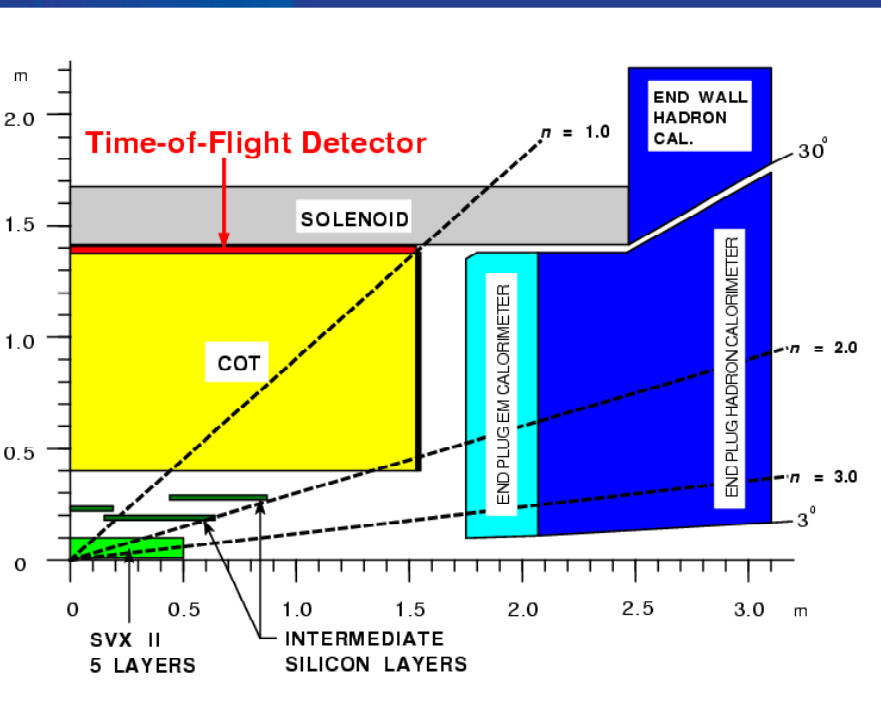
- Providing steady flow since fixes
- Good and stable sub-atmospheric pressures
- pH measured weekly from coolant samples
- Maintenance during each shutdown





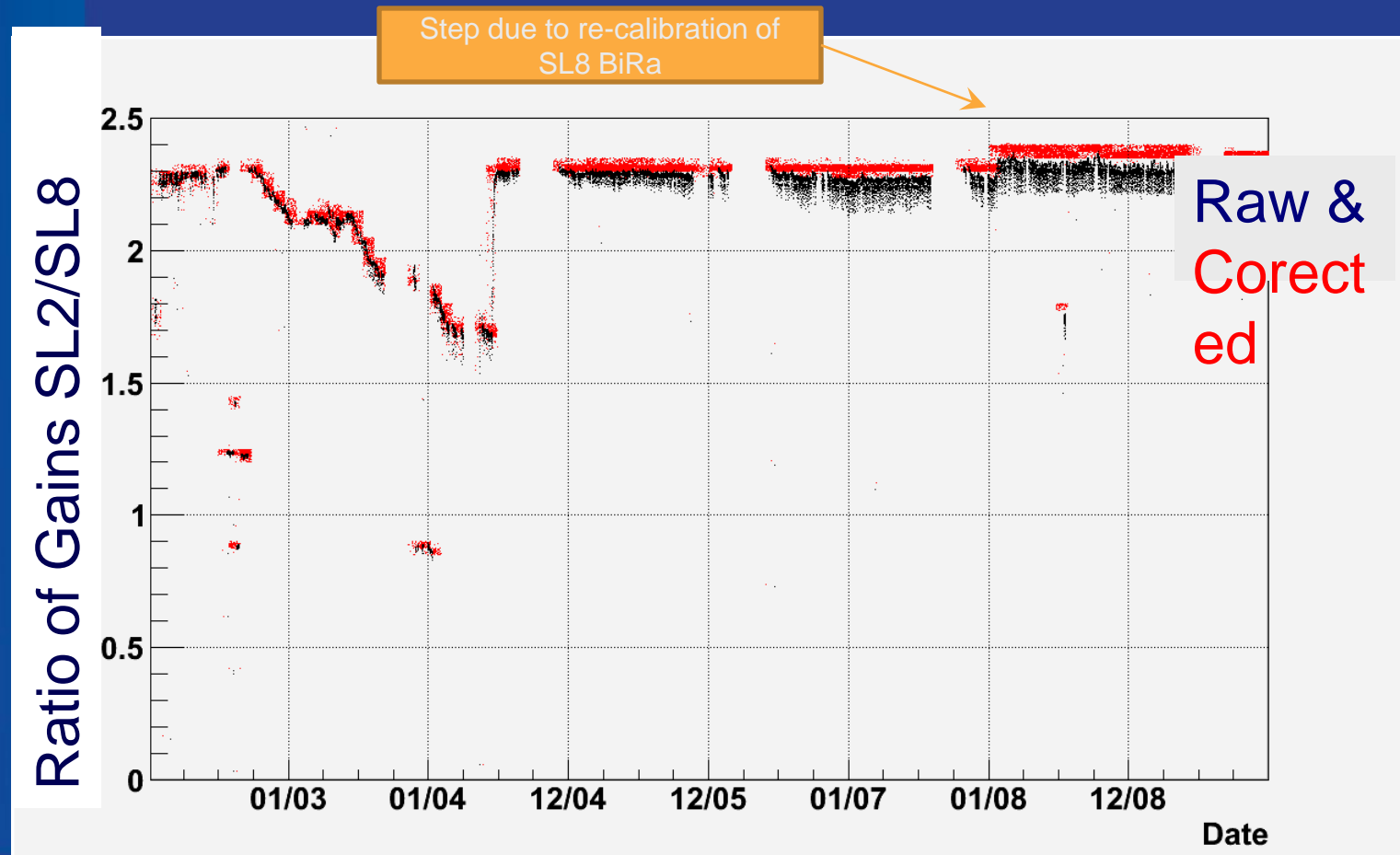
# Central Outer Tracker

- The COT is a cylindrical drift chamber with “miniature jet cells” divided into superlayers.
- The superlayers alternate between axial (2, 4, 6, 8) and small angle stereo (1, 5 at  $2^\circ$  and 3, 7 at  $-2^\circ$ ).



# Wire aging

- Since the recovery after adding  $O_2$ , the gain is steady.



# Conclusions

- CDF is functioning well and producing world class physics results in a timely fashion
- There is a strong “core” that wants to run this experiment 3 additional years
- The detector hardware is in good shape
- Physics studies are underway to quantify the detector degradation on tracking and tagging

# Back-ups

# CDF Author List

## CDF Default Author List April 2010 - October 2010

T. Aaltonen,<sup>22</sup> B. Álvarez González<sup>\*,10</sup> S. Amerio,<sup>42</sup> D. Amidei,<sup>33</sup> A. Anastassov,<sup>27</sup> A. Annovi,<sup>18</sup> J. Antos,<sup>13</sup> G. Apollinari,<sup>16</sup> J. Appel,<sup>16</sup> A. Apresyan,<sup>47</sup> T. Arita,<sup>56</sup> A. Artikov,<sup>14</sup> J. Asandi,<sup>52</sup> W. Ashmanskas,<sup>16</sup> B. Auerbach,<sup>59</sup> A. Aurisano,<sup>52</sup> F. Azfar,<sup>42</sup> W. Badgett,<sup>16</sup> A. Barbaro-Galtieri,<sup>27</sup> V.E. Barnes,<sup>52</sup> B.A. Barnett,<sup>24</sup> P. Barria<sup>\*,45</sup> P. Bartos,<sup>13</sup> M. Bauce<sup>\*,42</sup> G. Bauer,<sup>31</sup> F. Bedeschi,<sup>45</sup> D. Beecher,<sup>29</sup> S. Behari,<sup>24</sup> G. Bellettini<sup>49,45</sup> J. Bellinger,<sup>58</sup> D. Benjamin,<sup>15</sup> A. Beretvas,<sup>16</sup> A. Bhatti,<sup>49</sup> M. Binkley<sup>\*,16</sup> D. Bisello<sup>\*,42</sup> I. Bizjak<sup>41,29</sup> K.R. Bland,<sup>5</sup> C. Blocker,<sup>7</sup> B. Blumenfeld,<sup>24</sup> A. Bocci,<sup>15</sup> A. Bodek,<sup>48</sup> D. Bortoletto,<sup>47</sup> J. Boudreau,<sup>46</sup> A. Boveia,<sup>12</sup> B. Brau<sup>\*,16</sup> L. Braggiadori<sup>16,6</sup> A. Brisuda,<sup>13</sup> C. Bromberg,<sup>34</sup> E. Brucken,<sup>22</sup> M. Bucciantonio<sup>44,45</sup> J. Budagov,<sup>14</sup> H.S. Budd,<sup>48</sup> S. Budd,<sup>23</sup> B. Burkett,<sup>16</sup> G. Busetto<sup>\*,42</sup> P. Bussey,<sup>20</sup> A. Buzatu,<sup>32</sup> S. Cabrera<sup>\*,15</sup> C. Calancha,<sup>30</sup> S. Camarda,<sup>4</sup> M. Campanelli<sup>34</sup> M. Campbell,<sup>33</sup> F. Canelli<sup>12,16</sup> A. Canepa,<sup>44</sup> B. Carls,<sup>23</sup> D. Carlsmith,<sup>58</sup> R. Carosi,<sup>45</sup> S. Carrillo<sup>\*,10</sup> S. Carron,<sup>16</sup> B. Casal,<sup>10</sup> M. Casarsa,<sup>16</sup> A. Castro<sup>66,6</sup> P. Catastini,<sup>16</sup> D. Catz,<sup>53</sup> V. Cavaliere<sup>\*,45</sup> M. Cavalli-Sforza,<sup>4</sup> A. Cerri<sup>7,27</sup> L. 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# Higgs Projections



## 2xCDF Preliminary Projection

